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THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

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RECENT DEVELOPMENTS IN ASTRONOMY

By RALPH E. DELURY

(Outline of Annual Address of the President, January 15, 1937)

EACH year contributes many routine visual, photographic and spectrographic observations to the great astronomical store from which is drawn from time to time the material for star catalogues, statistical reports and investigations of individual bodies and systems. Taking part in this international work are about 330 active observatories in which are engaged possibly not more than 3,000 observers. National observatories, especially, supply the continuous observations of positions of stars and planets on which are based the national time services and surveys, and the survey of the universe; while the observatories of universities and institutions are concerned mainly in the physical investigations of the universe. In addition, there are many individuals who, with modest equipment, pursue astronomy as an obsessing hobby, contributing much to the study of meteors, variable stars, and the discovery of comets and "new stars" which might be missed by the astronomer engaged in his continuous special program of observations. Many of these enthusiastic individuals would welcome the opportunity of observing with large telescopes, the need for many more of which is apparent; and the time seems ripe for their "mass production" at much lower cost.

In addition to the continuous routine observations, each year brings its own specially interesting astronomical events, phenomena and discoveries; and those of the past year rank highly in interest and importance. Notable improvements increasing the power of astronomical equipment were applied; the construction of several large telescopes went on apace; three comets and an interesting minor

planet were discovered and determinations of their orbits were made; a total solar eclipse was successfully observed; the extensive work on a large star catalogue was completed; several of those exceedingly bright "flares" known as "novae" appeared and were observed intensively; and the photographic and spectrographic observation of nebulae was extended farther into the depths of space and time. These and other recent developments will be sketched as part of the general astronomical picture, attention being directed particularly to those relating to position and distance.

Equipment

The reflecting power of telescope mirrors has been improved considerably by the new evaporated films of aluminium or of aluminium with chromium. The resulting aluminium oxide is a particularly good reflector of violet and ultra-violet light. This fact is of special advantage in stellar spectrography, since the ultra-violet end of the spectrum is relatively weakened by the absorption in the terrestrial and stellar atmospheres, and work in this field has been greatly stimulated.

Recent improvements made in photographic plates have been of the greatest value to astronomy. The speed of emulsions, reduction in size of the grain and colour sensitivity are being continually improved. The production of plates sensitive in the infra-red region of the spectrum has opened up many fields of astronomical investigation. Nebulae and stars hitherto unknown have been discovered. Photography of the heavens in infra-red light will reveal many low temperature stars and much concerning absorbing material in space. Re-investigation of spectroscopic binaries in many cases may reveal an infra-red spectrum of the "dark companion" star, making possible the determination of the individual masses of the two stars.

The use of the Schmidt high speed combination of spherical concave mirror and correcting plate has proven its worth in direct photography and in spectrography by lessening exposure-time in the investigation of the weakest light-sources.

Progress was made in the construction of the large Texas, Michigan and Mt. Palomar reflecting telescopes. The 200-inch disc of the latter was delivered in Pasadena early in the year and is un-

dergoing the slow grinding operations; while the mountings and observatory, which is to have a dome 135 feet in diameter weighing 750 tons, are being built. (A model of this great telescope on a one-fiftieth scale, was constructed at the David Dunlap Observatory and exhibited at the meeting.)

Phenomena and Discoveries

The total solar eclipse of June 19th, the path of which extended from the Mediterranean Sea to Japan, was successfully observed by some of the expeditions. Clouds scattered in time to permit the Harvard College-Massachusetts Institute of Technology party, and that of the Pulkowa Observatory, to secure their program of observations. Dowmetal, a new strong light-weight alloy of magnesium, was used in constructing the apparatus employed by the Harvard party. Photographic exposures were automatically controlled. New coronal spectrum lines were discovered by Dr. Menzel, and the strengthening of certain lines indicated an abnormally high degree of excitation. Dr. Gardiner secured a beautiful colour photograph of the corona, the first to be obtained.

The cycle in sunspot relative numbers has been progressing from its minimum at 1933.9, and if of average length will reach a maximum about 1938.5. The reversal in the magnetic polarities in pairs of spots following the minimum was observed at Mt. Wilson to be in keeping with their earlier findings. Every few years it has been of interest to note the differences between the observed cycle in sunspot numbers and that predicted by Kimura in 1912, since his computed curve fitted the cycles of numbers so perfectly up to that time. Is the divergence due to error in the earlier derived curve of sunspot numbers or to new factors or causes entering the picture since then? From recent developments one may hazard the guess that the next maximum of sunspot numbers will be above the average, like that of 1917. The influence of the sunspot cycle seen in many terrestrial phenomena has long been ascribed by me to increased ionization of the terrestrial atmosphere caused by ultra-violet light emanating from the large areas of high-level clouds which surround the sunspot groups and increase in number and size with them. We may consequently expect in the next two years

occurrences such as we had in 1917-18. It will be remembered that influenza and meningitis were rampant at that time, and it is recognized that certain epidemics are related to certain types of weather; so that it is not unreasonable to expect that the present mild epidemics of influenza may develop into more serious phases in the next year or two.

The continued investigation, by Dr. Pettit at Mt. Wilson Observatory, of the velocities of ejection of prominence material from the sun, has apparently established that the velocity increases a step at a time by a definite increment or by small multiples of the increment.

We may assume that stars in general, like the sun, are continually throwing material out into space. It has been known for years that calcium and sodium are present in interstellar space, as indicated by their undisplaced spectrum lines revealed in the shifted spectra of rapidly moving light-sources. During the past year Drs. Adams and Dunham, Mt. Wilson Observatory, discovered the presence of ionized titanium in interstellar space, as revealed by its spectrum lines, λ 3229, λ 3241 and λ 3384.

A very small minor planet, which has been named Adonis, came very close to the earth and was discovered by Professor Delporte of Belgium.

The observation in Canada of meteors, organized and stimulated by Dr. P. M. Millman, has developed in a gratifying manner.

Three comets were discovered during the past year by Peltier, Kaho and Jackson. Peltier's comet approached to within 16 million miles of the earth, early in August, and became visible to the naked eye. The chart of its orbit (The Telescope, July-August, 1936) shows the plane of its orbit inclined 78°.5 to that of the earth, and a perihelion distance of about 102 million miles. Apart from the study of their low temperature molecular spectra, and the determination of their orbits and perturbations by planets (as in the classic investigation by Clairaut of Halley's comet ere its return in 1759), comets should be investigated in relation to solar variations, both as to their sudden changes and their changing brightness on successive returns, in view of the interesting apparent relationship between the sunspot cycle and the brightness of Encke's comet on its returns

every 3.3 years, discovered by Bosler. In this connection it is interesting to note that Halley's comet was disappointingly faint on its last return in 1910 when sunspots were comparatively scarce. Was the historically brilliant spectacle it presented in 1066 due to an excessive emission of ultra-violet light at or near a sunspot maximum? The Chinese records of sunspots indicate that a maximum probably occurred between 1077 and 1079, and by inference a maximum would be near 1066. More definitely, if we look into the measurements made by Professor A. E. Douglass, of the annual growth-rings of the giant redwoods of California, we find for the five 11-year cycles centred about 1066, a mean cycle indicating that 1066 was probably near a sunspot maximum, since these trees show greater growth at maximum than at minimum of spots (for the years 1784-1869 investigated for other purposes). Sudden changes in comets may be associated with solar disturbances as is the case with terrestrial electromagnetic effects.

In the past year several novae were observed, one discovered in June in Lacerta, one in September and another in October in Aquila, and a fourth in October in Sagittarius. Two "supernovae" were found in distant nebulae, one by Mt. Wilson in one of the nebulae of the Virgo cluster, and the other in a southern nebula, on a Harvard photograph. The intensive study of the spectra of the ordinary novae indicated the usual rapidly changing spectacle of the spectrum lines and the varying large velocities of different blasts of metallic vapours from these gigantic explosions, velocities so great as to isolate the interstellar H and K calcium lines.

Using the new photographic plates sensitive to infra-red light, Dr. Hetzler of Yerkes Observatory, discovered a number of invisible red stars. His investigations of long-period variables, revealed striking differences between their visible and infra-red light-curves. Drs. Struve, Elvey and Roach, using a Schmidt camera at McDonald Observatory, Texas, found a red nebula around Antares, apparently illuminated by starlight.

Positional Astronomy

In the oldest branch of astronomy, that of determining the positions and motions of the heavenly bodies as seen from the earth with

its various motions and oscillations making the problem more difficult, the struggle for precision of measurement and interpretation goes on ceaselessly. Each generation produces new and improved star catalogues, and at present we find the Third Fundamental Catalogue of the Berliner Jahrbuch, of 1,500 stars, and the new Albany General Catalogue of the Carnegie Institution, of 32,000 stars, about to replace those in use since 1900. Photographic methods have been increasingly supplementing the direct observations by transit and meridian circle instruments, especially for the fainter stars. According to Dr. H. R. Morgan there are now available positions for about 500,000 stars, proper motions for 100,000, radial velocities for 7,000 and parallaxes for 4,000 stars. The amount of observational and computational work involved in this stupendous task cannot be realized by anyone not engaged in it. Observers spend their lives building up this structure so vital to all branches of astronomy with the reward of adding to and increasing the precision of star positions. Yet, the task yields many by-products touching interesting physical problems.

One of these problems is the question of relative motion of the continents. From the theory developed by Wegener it would seem possible that the Americas drifted westward from Europe and Africa. To determine whether or not such a process is going on at present, an international attack was made on the problem in 1926, when observations of longitude with the aid of radio time-signals were made at numerous points on the continents. Certain questions arose in the use of the radio signals and the program was repeated in 1933. In the interval of seven years no appreciable drift of the continents is apparent; but an apparent difference in the velocity of the signals between day and night has been found, no doubt attributable to change in the length of the path. The program will likely be repeated after a longer interval.

Another interesting problem was raised by Newcomb's discovery of the long period (about 270 years) in the "errors" of the moon's longitude compared with that predicted by the gravitational theory of the solar system. Dr. Brown's more refined tables made it appear that difference between the observed and predicted longitudes was periodic in 262 years; and his work revealed a 60-year period in the

"errors" and also in those of some of the planets. He found that they synchronized with the 60-year cycle in the magnitude of the 11-year cycle in sunspot numbers, and suggested that possibly magnetic variations were responsible. The constancy of the unit of time, the daily rotation of the earth, was questioned. This could be caused to vary by oscillations in the radius of the earth, or by periodic transfers of material back and forth in latitude, such as the precipitation of tropical water vapour in polar regions and the subsequent return to equatorial regions. In either case meteorological fluctuations of the same periods should be present. Investigation at Ottawa of the Upsala precipitation and the annual growths of the California redwoods (measured by Huntingdon) give evidence of the presence of the two periods synchronizing with the longitude fluctuations. And now the recent developments of the free-pendulum and crystal clocks make it seem possible that changes in the rate of rotation may be measured. We anxiously await the results.

The aid of the precise measurements of the motion of the perihelion of Mercury and of star positions near the sun at the time of its eclipse, in the development of the theory of relativity, is well known.

The Distant Nebulae and the Red Shift

From multiples of a standard of length measured on the earth's surface the distance of the moon and sun have been derived by triangulation. The distance derived has been verified by spectroscopic measurements utilizing the velocity and wave-lengths of light which are in turn derived from multiples and subdivisions of the standard of length. From the diameter of the earth's orbit, known at least to one part in a thousand, the distances of the nearer stars have been found by triangulation. Measurements of greater distances are dependent on the statistical relationship between the periodicity and brightness of cepheid variables. If the periods of several cepheids in a distant nebula be found, the approximate distance for the nebula may be estimated. It has also been found that the spectra of nebulae are shifted more and more to the red with increasing distance, apparently in linear relationship. It is possible then to arrive at approximate distances for the most distant nebulae observable with the

spectrograph by measuring the extent of the red shift of the spectrum lines, the strong H and K lines of calcium, all fine lines being lost in the blended spectra of many stars. Statistically the red shift is greater with decreasing angular diameter of the nebulae. The recent work by Hubble and Humason at Mt. Wilson Observatory, on the photography and spectrography of the very distant nebulae has yielded a colossal picture of the universe. From the greatest red shift found it would appear that the light has taken upwards of a half billion years to reach the earth, or that it has travelled nearly 3×10^{21} miles. The observations have taxed the powers of the 100-inch telescope, and the endurance of the observers. No doubt the 200-inch telescope will reveal nebulae more than a billion light-years away!

The interpretation of the universe will depend on the cause of the red shift. If it be due to velocity of recession an explanation is offered by the relativity theory of an expanding universe, provided the guess as to the density of matter in space is in line. Dr. Hubble estimates about 10^{-26} grams per cubic centimetre. A new picture will be presented if the red shift be due to other causes. An obvious possible cause, investigated by several, is that the light loses energy on its long journey with resultant lengthening of wave-length.

A Theory of the Cause of the Red Shift

A new theory of the red shift, supplied by a new theory of light, may be briefly suggested: Just as we have had to retreat from the notion that the chemical elements were fundamental elements, so too it seems logical to suppose that the small dense proton and the large electron of light weight relatively to the proton, are composite bodies made of much smaller primordial particles. The electron is visualized as a bubble or loose cluster, the proton as a dense packing of these particles. The electron drives through an atom of hydrogen say, attaining the velocity of light as it approaches the proton, losing its electrical properties because of its transformation into a long shower of particles, and escaping with a velocity minutely lessened by the gravitational action of the proton which attains a velocity in the opposite direction of about 1-1850th of the velocity of light. As the shower passes the proton, the orbital motion of the

latter coupled with a rapid rotation of the shower on its long axis, introduces a spiralling structure in the shower. In the process the proton comes closer to the axis of the shower so that the velocity of escape of the front part of the spiral or wave is greater than the velocity of rear part. *Thus from its origin the front and back ends of a wave are separating exceedingly slowly, in other words the wave is lengthened in proportion to its age.* The theory also explains why the wave-lengths of hydrogen are longer than the corresponding wave-lengths of ionized helium, and determines the amount, as done by Bohr in another way. Measurements of the red shift in distant nebulae should be made with the H line as well as with the H and K lines.

Dominion Observatory,
Ottawa, Canada.

MINUTES OF THE ANNUAL MEETING OF THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

The Annual Meeting was held on January 12, 1937 in Room 18 of the Physics Building of the University of Toronto. Dr. Lachlan Gilchrist presided.

The Minutes of the last Annual Meeting were approved.

The Report of the General Secretary was read and adopted.

A motion of appreciation of Dr. Chant's editorial work for the JOURNAL of the Society was regularly moved, seconded and carried.

The General Treasurer's Report and the local Treasurers' Reports from the Centres were presented by Mr. J. H. Horning. Mr. E. J. A. Kennedy moved, Mr. S. C. Brown seconded that these be accepted.

Miss Budd gave the Librarian's Report, and Mr. Duncan read his report as Curator. These reports were accepted.

The Auditors and the officers of the past year were thanked for their services to the Society.

The scrutineers reported that the ballots showed almost unanimous acceptance of the list of officers as printed, whereupon the Chairman announced the election to office for 1937 of the following:

Honorary President—The Hon. Leonard J. Simpson, M.D., Minister of Education for the Province of Ontario.

President—R. E. DeLury, M.A., Ph.D., Ottawa.
First Vice-President—Wm. Findlay, Ph.D., Hamilton, Ont.
Second Vice-President—J. A. Pearce, M.A., Ph.D., Victoria.
General Secretary—E. J. A. Kennedy, 198 College St., Toronto.
General Treasurer—J. H. Horning, M.A., Toronto.
Recorder—R. H. Combs, Toronto.
Librarian—P. M. Millman, Ph.D., Toronto.
Curator—R. S. Duncan, Toronto.

Council —D. S. Ainslie, M.A., Ph.D., Toronto; S. C. Brown, Toronto; F. Napier Denison, Victoria, B.C.; Miss A. Vibert Douglas, Ph.D., Montreal; E. A. Hodgson, M.A., Ph.D., Ottawa; Dr. G. R. Magee, London, Ont.; J. E. Maybee, Toronto; A. Thomson, M.A., Toronto; L. A. H. Warren, M.A., Ph.D., Winnipeg.

CURATOR'S REPORT

There has not been the usual demand for lantern slides during the past year. The large telescope has been in use most of the time. I would like to suggest that some provision might be made in the future for securing a smaller telescope, possibly a two- or three-inch. The four-inch Cooke telescope is rather cumbersome for handling and transporting, and the smaller telescopes of the society, which were donated years ago, are not very satisfactory, being in need of constant care.

I would also like to make a suggestion regarding lantern slides. I think it would further the interest in astronomy if the society could secure or make up a number of sets of slides of ten to twenty-five slides each, accompanied with a printed talk on various phases of the science. These might be distributed, as requested, to other centres, clubs, churches, schools, etc., throughout the province. This might aid in popularizing astronomy.

ROBERT S. DUNCAN, *Curator.*

LIBRARIAN'S REPORT

The periodicals received by the Society in exchange for the JOURNAL have slightly increased during the year. The more technical of these have been sent to the David Dunlap Observatory as before, and the amateur and popular issues displayed in the library for readers.

A list of the observatories and societies to which the JOURNAL is sent in exchange is published in the November number.

26 Volumes have been bound during the year at a cost of $58.59.

146 Books have been borrowed by Members.

Additions to the library during the year include periodicals from:

Canada and the Empire	151
The United States	173
Other Countries	218
	542

6 Books have been added by purchase and 2 by presentation.

PETER M. MILLMAN, *Librarian.*

REPORT OF THE GENERAL SECRETARY

The membership of the Society is approaching the 1,000 mark, showing a slight increase over the previous year. There are now ten Centres, located throughout the Dominion from Montreal to Victoria. The Maritime Provinces are not yet represented. We are pleased, however, to report that information has been requested with a view to establishing a centre in Halifax. While the membership figures show an increase it is only fair to point out that were it not for an addition of 24 Members at Large, the Society in Canada as a whole would show a decrease in numbers. These Members at Large reside in nearly every country on the globe; it is interesting to know that places as widely scattered as Java, Palestine, the Argentine, and Egypt all have their quota as well as the principal European nations. The importance and great attractiveness of the subject of astronomy merit a very careful study by membership committees in their efforts to increase our numbers; we urge the secretary of each Centre to put this matter earnestly before his Council.

It is to be noted that the interest on the part of nearly all the Centres has been greater this past year than for some time. The secretaries and treasurers are to be commended in that their lists have been more representative of the true standing of the Society. Many delinquents have been purged from the rolls, and fees more promptly remitted. We expect, therefore, that a better showing in increase of membership will result during 1937. During the year a complete Membership Roll was printed in the JOURNAL. It is five years since the last such list was published as its preparation entails a lot of labour on the part of the office secretary and the Editor of the JOURNAL, we hope it will be of use and interest to the members.

A list of the many important lectures which were given throughout the year in the meetings of the Centres will be found in this number of the JOURNAL. Particular attention is drawn to a Summer Course in astronomy which was given by the Victoria Centre. A description folder of this course came to this office and no doubt the Victoria Secretary would mail one to any of the other Centres interested.

Reference should be made to the publications of the Society, the JOURNAL and the OBSERVER'S HANDBOOK. In the JOURNAL for September, 1936, there is a list of subscribers to the publications, and a list of exchanges. These will show that our JOURNAL is to be found in most of the important scientific libraries in all parts of the world. It should be a source of pride and gratification that the R.A.S.C. is so well and favourably known in the circles of astronomical knowledge everywhere. A debt of gratitude is due to our Editors, and especially to Dr. C. A. Chant who has given unstintingly of his time (without remuneration) to the Society for a period of 30 years, ever since the first issue of the JOURNAL.

E. J. A. KENNEDY, *Secretary.*

MEMBERSHIP OF THE SOCIETY

The Membership of the Society on December 31, 1936 as shown by the Reports of the various Centres, was as follows:

	1935	1936
Toronto	177	186
Ottawa	65	64
Victoria	122	114
Montreal	123	124
Winnipeg	38	45
London	48	51
Hamilton	58	41
Vancouver	48	43
Edmonton	48	47
Calgary	12	12
Members at Large	143	167
Life Members not in Centres	...	12
Total	882	906
Additional subscribers to JOURNAL	59	75

EVA M. BUDD, *Assistant Secretary.*

REPORTS FROM THE SECRETARIES OF THE CENTRES

EDMONTON CENTRE

The number of paid-up members is now 47. During the year one member died and nine have resigned or allowed their member-

ship to lapse. Seven new members have been elected, Messrs. J. H. Oglivie, H. B. Doughty, Max Wyman, C. P. Willoughby, T. W. Brown, J. Nolte, and Dr. W. N. Condell.

The Council has met twice. Seven regular meetings were held, beside the annual dinner meeting. The principal speakers were as follows:

Jan. 9—Dr. A. J. Cook: The Evolution of the Solar System.
Feb. 13—Mr. J. G. Taylor: An Astronomer's Life (the life of E. B. Frost).
Mar. 12—Dr. J. W. Campbell: Description of the set of transparencies presented by the Centre to the University of Alberta.
Apr. 9—Prof. I. F. Morrison: Astronomy and Surveying.
May 7—Dr. E. H. Gowan: Römer, Bradley, and the Velocity of Light.
Oct. 8—Mr. R. Chambers: The Ben Nevis Observatory.
Nov. 12—Prof. E. S. Keeping: Planetaria.
Dec. 10—Mr. D. E. Cameron: Astronomy in the Bible.

A picnic was held on Oct. 23rd at the home-made telescope of Mr. C. G. Wates, and afterwards at the home of Mrs. Clarke. Visibility was good early in the evening.

At the annual banquet held on Dec. 10th the officers were elected for 1937.

At the November meeting some books borrowed from the Society's library at Toronto were available for members. These were much appreciated and were all borrowed.

The Centre has also commenced the formation of a small library of its own, with the purchase of a star-atlas and a few good books on popular astronomy.

E. S. KEEPING, *Secretary*.

HAMILTON CENTRE

During 1936 there were seven regular meetings:

Jan. 16—Prof. H. F. Dawes: The Telescope.
Feb. 13—H. Simmonds and G. Freeman: Saturn and its Rings.
Mar. 23—Dr. P. M. Millman: Stardust Near and Far.
Apr. 27—T. H. Wingham: Distances of the Stars.
Oct. 1—Round table discussion by members on personal observations, notably Dr. Jeffrey Bell and his ten-year consecutive record of sun-spots which was passed around for inspection.
Nov. 5—Geo. E. Campbell: Some Paradoxes in Astronomy.
Dec. 3—Dr. H. R. Kingston: The Way of the Moon.

On May 28 the Centre's annual field-night was held at the home of Mr. W. T. Goddard. Eight telescopes, several of which were products of the craftmanship of the members, were used by approximately 300 amateur astronomers and their friends. Refreshments were served by the host and his family.

An important feature of our meetings consists in having two members briefly report, before the regular lecture, the latest astronomical discoveries and theories, and the current positions of the constellations. During the present year, Dr. Findlay and Mr. Mallory have provided these commentaries. The older members probably most appreciate the latest discoveries, while the younger members enjoy learning the constellations and phenomena. The October meeting disclosed that Alderman J. A. Marsh had been photographing Peltier's Comet and Jupiter's moons, and that Mr. T. H. Wingham had been methodically observing sunspots and charting them with the co-operation of Prof. W. Findlay. They also observed the Perseid meteors during the period set for this task.

Lecturers have been largely drawn from among our own members, some of whom have prefixes to their names, while a high percentage can display letters after their names. We were able to present one of the two visiting lecturers with a packed house.

There were 41 members in good standing at the beginning of 1936, losses amounted to four, while five new applicants for 1937 will bring the total membership to 42 in the beginning of the new year. Prof. A. E. Johns has been the president throughout a successful year and has been re-elected to carry on for the next year. Mr. John Marsh has acted as advance publicity man, having the required amount of influence with the local press.

N. H. BROADHEAD, *Secretary*.

LONDON CENTRE

During the year 1936, the London Centre held nine regular meetings with a total attendance of 207.

Jan. 10—Dr. H. R. Kingston: Further Developments in Calendar Reform. Attendance 26.

Feb. 14—Mr. L. G. Planques—The Moon—illustrated by a one-reel motion picture "A Journey to the Moon". Short talks on the topics "Day and Night on the Moon", "Possibility of Life on the Moon", "Rockets to the Moon", presented by G. R. Magee, Miss F. Jacobs, and Mrs. A. E. Davies, respectively. Attendance 36.

Mar. 13—Prof. W. J. Russell, Dept. of Geology, University of Western Ontario: The Pre-Cambrian Period. Attendance 19.

Apr. 17—Rev. R. J. Bowen: "Jupiter", illustrated by a one-reel motion picture dealing with Jupiter and its satellites. The phenomenon of the Precession of the Equinoxes was described by Rev. W. G. Colgrove, illustrated by a model belonging to the University of Western Ontario. Attendance 32.

May 8—Dr. H. R. Kingston: Evolution (from the point of view of an astronomer). Attendance 24.

May 30—Annual Picnic, held in conjunction with the Regional Gathering of the Federation of Ontario Naturalists. Attendance 26. Afternoon and evening observations through the telescopes.

Oct. 9—Dr. H. R. Kingston: Spanning the Solar System. Attendance 17.

Nov. 13—Rev. W. G. Colgrove: The Sun. Attendance 27.

Dec. 11—Annual Meeting: Reports of Treasurer, Secretary; election of officers for 1937; travel talk on Alaska, by Rev. R. J. Bowen. Attendance 25.

The London Centre is greatly indebted to Mr. E. H. McKone for excellent presentations of Constellation Studies throughout the year 1936.

OBSERVER'S HANDBOOK discussions, conducted by Dr. Kingston, were also features of the monthly meetings.

One Executive Committee Meeting was held on January 3 to draw up a programme for the year.

Under the capable direction of Mr. J. Middlebrook the Meteor Observation Group of the London Centre observed and plotted the Perseid shower of last August and also the Leonid shower of last November. The results of these observations have been sent to Toronto.

The total membership for the year 1936 was 39.

G. R. MAGEE, *Secretary*.

MONTREAL CENTRE

Membership in the Society at this date is 124. Sixteen new members were enrolled and fifteen names withdrawn for various reasons.

Seven meetings were held during the season 1935-36. The subjects and speakers are listed as follows:

1935 Oct. 31—Mr. A. Donnelly: Telescope Making. Mr. F. DeKinder: Summer Observations.
Nov. 28—Dr. R. DeLury (Ottawa): Sunspots.
1936 Jan. 23—Mr. E. Russell Paterson: What a Star Really is. Mr. Henry F. Hall: The Constellations.
Feb. 27—Dr. W. D. Lighthall: Astronomical Knowledge of the Mayas.
Mar. 12—Mr. R. A. Hamilton: Man and the Universe in Chaucer's Time.
Apr. 2—Dr. Arthur Haas (Vienna): Cosmological Problems of Physics (joint meeting with McGill Chapter Sigma Xi).
Apr. 3—Dr. Arthur Haas (Vienna): Some Fundamental Ideas of Physics (joint meeting with McGill Physical Society).

Observational meetings were held weekly from May 28th until late autumn and the thanks of the Society are due the members of the Telescope Committee who made this possible.

A. V. DOUGLAS, *Secretary*.

OTTAWA CENTRE

During the year there were two council meetings and several emergency executive meetings.

The centre sponsored one public lecture entitled "Star Dust Near and Far", the speaker being Dr. P. M. Millman of the University of Toronto. About 90 people attended.

Meteor observations were carried out during the Perseids, August 9 to 13, and during the Leonids, November 14 to 17. Both visual and photographic results were obtained, computations on the latter being made at the Dominion Observatory and forwarded to Dr. P. M. Millman of Toronto. Twenty-six people were active observers, most of them being high school students. These observations were carried on at Ottawa, and at the Y.M.C.A. Camp, Golden Lake, Ontario. Ottawa observations were made from the roof of the Observatory and by courtesy of the Director, Dr. E. A. Watson, from the roof of the Health of Animals Research station, Hull, Quebec.

Membership at the end of 1935 was sixty-five. During the year one was reported deceased, one resigned, two were dropped

for non-payment of fees, and three new members were enrolled. This makes a net loss of one, and our membership now is sixty-four.

The usual correspondence and notices concerning meetings was attended to. Preliminary arrangements have been completed for a visit in January, 1937, to Montreal, Ottawa and Toronto centres by Dr. D. H. Menzel, of Harvard College Observatory.

This centre is co-operating as the astronomical unit on the science council which is preparing for the 1938 summer meeting of the A.A.A.S. in Ottawa.

As in the past, and through the courtesy of the Director, Mr. R. Meldrum Stewart, Observatory star maps have been sent to new members, while all members of the centre have received the Saturday Evening Programme Bulletin.

MALCOLM M. THOMSON, *Secretary.*

TORONTO CENTRE

Membership as on December 31, 1936:	
Resident in Toronto	136
Life Members	8
Non-resident Members	42
Total	186

There were 177 members one year ago, since then 20 were elected with 11 resignations, the net gain therefore being 9 members. This gain is probably a reflection of improved business activity.

The speakers and subjects during 1936 were as follows:

Feb. 18—J. F. Heard, M.A., Ph.D.: Eclipsing Binaries.
Mar. 3—H. J. C. Ireton, M.A., Ph.D.:Applied Spectroscopy.
Mar. 17—Dr. Elizabeth Allin: The Structure of Atomic Nuclei.
Mar. 31—Mr. H. G. Duncalfe: Parallax of a Star. J. Satterly, M.A., Ph.D.: The Age of the Earth.
Apr. 14—S. Beatty, M.A., Ph.D.: Concepts of Velocity, Acceleration, Energy and Potential.
Apr. 28—Dr. C. A. Chant: Recent trip through Eastern States.
Oct. 6—Moving Pictures: "A Trip to the Moon" and "Total Eclipse of Sun, 1932", shown by Mr. Robert H. Combs.
Oct. 20—Dr. R. K. Young: The Work of the Observatory.

Nov. 3—Dr. P. M. Millman: Some Recent Advances in our Knowledge of Shooting Stars.
Nov. 17—Mr. G. K. Dalton: Recent Observations. Mr. R. H. Combs: McMath-Hulbert Motion Pictures.
Dec. 1—A. Thomson, M.A.: Recent Progress in Meteorology.
Dec. 15—Mr. J. R. Collins: Legends of the Winter Constellations.

The meetings of April 28th and October 20th deserve special mention, in that they were held at the David Dunlap Observatory. At the first meeting, the intricacies of the new large telescope were explained in detail, and at the second the members were fortunate enough to be able to view selected objects through the 19-inch and 74-inch telescopes.

To the Director and staff are extended special thanks from the members and their friends for their kindness, and endeavours towards making these two evenings very enjoyable ones indeed. Probably most of the visitors had never previously viewed any celestial object excepting through small instruments, or seen at first hand the results of the routine work of an observatory, and certainly no audience could have shown more attention and appreciation to those in charge of the instruments and exhibits.

The long evening's efforts made everyone hungry, so the refreshments provided no small part of the programme.

S. C. Brown, *Secretary.*

Vancouver Centre

During 1936 seven regular meetings have been held. In addition during the summer months three out-of-door garden telescope meetings were arranged, but on account of the weather only two could be held.

Jan. 14—Dr. D. C. B. Duff: Laboratory Methods in Bacteriology.
Feb. 11—Dr. W. E. Harper (Dom. Astrophysical Obs.): Astronomy and the Poets.
Mar. 10—Dr. J. D. Davidson (University of B.C.): Color.
Mar. 14—J. Teasdale and J. C. Jorgensen: Making of Telescopes and Lenses.
May 12—Annual Dinner and Members' night. The dinner was held in the Union College Dining-room, U.B.C., after which members adjourned to the Science Building, and listened to two short talks by Mr. C. A.

MacDonald and Mr. H. P. Newton on "Sailing Circles" and "Saturn's Rings" respectively.

July 18—Outdoor garden meeting at the home of Mr. J. Teasdale, well attended.

Aug. 8—Outdoor meeting at the home of Mr. H. P. Newton, large number attending.

Oct. 13—Dr. A. McKellar (Dom. Astrophycisal Obs.): The Architecture of our Universe.

Nov. 17—Dr. G. M. Shrum (University of B.C.): Atomic Collisions, with interesting experiments.

Two Council Meetings were held during the year, on Mar. 10, and Nov. 17.

J. W. MOORE, *Secretary*.

WINNIPEG CENTRE

Six scheduled meetings were held with lectures. In addition the observation night, May 28th, was most successful.

Four members were added up to the date of Annual Meeting, which closed with an active membership of 45; soon to be 46. Some half-dozen delayed subscribers for 1935 were held within the fold and duly responded.

The audit of accounts showed an increasing strength in the organization.

The closing Presidential Address was given Dec. 9th by Mr. A. V. Piggott, speaking on the Planetesimal Theory.

At this meeting 10 advance subscriptions were to hand.

A programme for 1937 was subsequently arranged, which was given press publicity.

G. P. MORSE, *Secretary*.

FINANCIAL STATEMENTS, 1936

I. GENERAL TREASURER

GENERAL ACCOUNT—No. 4359

Receipts		Disbursements	
Bank Balance, 1935 ($338.47 to Southam Press Fd.)	$1,794.67	Publications	$2,419.85
Grants received	$2,270.00	Public Meetings	83.87
Fees	1,514.82	Discount and interest wrongly credited	37.00
Publications	259.23	Stamps and Stationery	323.66
Interest	134.32	Salary, Asst. Sec.-Treas.	660.00
Stamps and Stationery	19.88	Janitor	12.00
So. Pr. Bonds maturing	300.00	Guarantee Investment Certificates for Southam Press Fund	700.00
		Grants to Centres	695.50
		Miscellaneous	12.50
		Rent	120.00
		Bank Balance	1,228.54
	$6,292.92		$6,292.92

LIFE MEMBERS ACCOUNT—No. 4390

Receipts		Disbursements	
Bank Balance—1935	$240.73	Guarantee Investment Certificates	$200.00
Three Life Memberships	75.00	Bank Balance	117.98
Bank Interest	2.25		
	$317.98		$317.98

BUILDING FUND ACCOUNT—No. 4383

Receipts		Disbursements	
Bank Balance, 1935	$919.96	Guarantee Investment Certificates	$1,000.00
Bond Interest	175.00	Bank Balance	102.23
Bank Interest	7.27		
	$1,102.23		$1,102.23

SOUTHAM PRESS FUND ACCOUNT

Receipts		Disbursements	
Balance, 1935 (in Gen. Acc.)	$338.47	Guarantee Investment Certificates	$700.00
Bank Interest	4.67	Balance (in Gen. Acc.)	8.14
Bond Interest	65.00		
Bond Maturing	300.00		
	$708.14		$708.14

Audited and found correct, January 8, 1937.

(Signed) A. R. Hassard, Andrew Thomson } *Auditors.*

J. H. HORNING, *General Treasurer.*

MEMO—BONDS HELD BY IMPERIAL BANK (YONGE AND QUEEN) FOR SAFE-KEEPING

Acct. belonging to	Description of bonds	Face value	Date of mat.	Dates of Int.	Rate of Int.	Half year c'p'n.	Total yearly Int.
Life Membership Account	1. D. of C. R_2TA 083071	$100.00	1943	Apr. 15	5%	$2.50	$5.00
	2. D. of C. R_2TA 083072	100.00	1943	Oct. 15	5%	2.50	5.00
	3. Can. Perm. Mtge L20933	100.00	1937	June 1 Dec. 1	5½%	2.75	5.50
	4. Tor. Gen. Trust G9538	100.00	1941	31–12	3½%	1.75	3.50
	5. Tor. Gen. Trust G9539	100.00	1941		3½%	1.75	3.50
Totals		$500.00					$22.50
Building Fund Account 4383	1. D. of Can. C E014437	1000.00	1949	Oct. 15 Apr. 15	3½%	$17.50	$35.00
	2. D. of Can. NE029210	1000.00	1941	May 15 Nov. 15	5%	25.00	50.00
	3. Can. Per. Mge. L15591	500.00	1940	June 1 Dec. 1	3¾%	9.37½	18.75
	4. " " " L15592	500.00	1940	Dec. 1	3¾%	9.37½	18.75
	5. " " " L20932	500.00	1937	Dec. 1	5½%	13.75	27.50
	6.	500.00	1941		3½%	8.75	17.50
	7. Tor. Gen. Trust G9535	500.00	31–12 1941		3½%	8.75	17.50
	8. Tor. Gen. Trust G9536	500.00	31–12 1941		3½%	8.75	17.50
Totals		$5000.00					$202.50
Southam Press Fund Account	1. D. of Can. N E008218	1000.00	1941	May 13 Nov. 15	5%	$25.00	$50.00
	2. Tor. Gen. Trust G9537	500.00	1941		3½%	8.75	17.50
	3. Tor. Gen. Trust G9540	100.00	1941		3½%	1.75	3.50
	4. Tor. Gen. Trust G9541	100.00	1941		3½%	1.75	3.50
Totals		$1700.00					$ 74.50
Total all accounts		$7200.00					$299.50

II. TREASURER'S REPORTS OF CENTRES

1. TORONTO

Receipts		Disbursements	
Balance, 1935	$213.68	Rent	$ 48.00
Grant from General Council	182.50	Printing Notices	18.00
		Advertising	7.30
		Catering	80.00
		Stamps, etc., Gen. Treas	17.08
		Caretaker, Observatory	3.00
		Postage, Local Treas.	.38
		Balance	222.42
	$396.18		$396.18

2. MONTREAL

Receipts		Disbursements	
Balance, 1935	$268.96	Fees to Gen. Treas.	$208.00
Members' Fees	208.00	Expenses re Meetings	83.05
Grant from Gen. Treas.	115.00	Postage and Stationery	16.71
Bank Interest	7.61	Secretarial assistance	10.00
		Sundry Gen. Expenses	4.43
		Telescope Expense	136.85
		Library Expense	19.83
		Balance	120.70
	$599.57		$599.57

3. OTTAWA

Receipts		Disbursements	
Balance, 1935	$102.65	Dues to Toronto	$112.00
Dues collected, 1936	43.00	Flowers	4.95
Grant from Gen. Treas.	92.35	Advertising	4.00
Bank Interest	1.06	Expenses, Lecture	30.00
		Flora Printers	4.65
		Cheques commission	.33
		Balance, 1936	83.13
	$239.06		$239.06

4. LONDON

Receipts		Disbursements	
Bank Balance, 1935	$ 80.67	Annual Meeting	$ 11.21
Grant from Gen. Treas.	48.00	Honorarium	5.00
Fees for 1936	78.00	Movie Film Rentals	10.66
Bank Interest	.95	Flowers	3.00
		Photographic Expense	3.50
		Secretarial Expense	23.15
		Balance	151.10
	$207.62		$207.62

5. HAMILTON

Receipts		Disbursements	
Bank Balance, 1935	$ 0.44	Fees to Gen. Treas.	$ 74.00
Grant from Gen. Treas.	29.00	Rent	15.00
Fees collected	74.00	Printing and Stationery	9.45
Fees in advance	24.00	Postage	9.22
Donations	6.00	Lecture Expense	7.35
Bank Interest	.46	Loan repaid	13.00
		Balance	5.88
	$133.90		$133.90

6. WINNIPEG

Receipts		Disbursements	
Bank Balance, 1935	$ 0.43	Balance owing Treasurer	$ 5.00
Grant, less 15c. exchange	34.85	Postage	5.84
Dues for 1934	2.00	Janitor	2.00
" 1935	10.00	Lantern Operator	2.00
" 1936	68.00	Rent	7.50
" 1937	2.00	Library	3.17
Bank Interest	.75	To Gen. Treas.	82.00
		Bank Balance	10.52
	$118.03		$118.03

7. EDMONTON

Receipts		Disbursements	
Balance, 1935	$ 57.01	Secretary's Supplies	$ 7.50
Fees collected	103.00	Treasurer's Supplies	1.50
Grant from Gen. Treas.	48.85	Chicago U. Transparencies	44.54
Bank Interest	2.31	Postage and duty	1.18
		Printing Titles	2.01
		Printing Membership Cards	4.18
		Slide Expenses	2.00
		Refreshments	7.50
		Fees to Toronto	86.15
		Cheque tax	.03
		Balance	54.58
	$211.17		$211.17

8. VICTORIA

Receipts		Disbursements	
Balance	$ 24.32	Rent, Y.W.C.A.	$ 25.00
Dues from Members	177.00	Printing, etc.	20.31
Grant from Gen. Treas.	108.50	Postage	10.25
Summer Course, net	11.85	Exchange on cheques	.40
Bank Interest	1.65	Advertising	4.24
		Miscellaneous	8.35
		Dues to Toronto	
		Balance, 1935	141.00
		On acct., 1936	59.00
		Balance	54.77
	$323.32		$323.32

9. VANCOUVER

Receipts		Disbursements	
Balance	$ 5.68	Fees to Toronto	$ 68.00
Fees	74.00	Postage and Post Cards	4.00
Grant from Gen. Treas.	36.00	Dr. Harper's Expenses	9.00
Bank Interest	1.19	Dr. McKellar's Expenses	7.00
		Stationery	16.29
		Exchange	.15
		Balance	12.43
	$116.87		$116.87

A COMPARISON OF ROTATING SECTOR AND STEP-SLIT AS METHODS OF PLATE CALIBRATION

By R. M. Petrie and A. McKellar

THE calibration of photographic plates for spectrophotometric purposes has been a subject of interest in recent years and many devices for producing such a calibration have been proposed.* In this note results are given for a comparison of two neutral methods; the rotating sector and the step-slit.

In this comparison our procedure was to secure calibrations by the two methods upon one photographic plate, using the calibrating spectrograph ordinarily employed in our spectrographic work. This is a single prism instrument yielding a linear dispersion of 53 A/mm. at Hγ and 114 A/mm. at Hα. The rotating sector is mounted in front of the spectrograph slit (0.53 mm. wide) and rotates at the high speed of approximately 6,000 revolutions per minute, this speed being employed in order to avoid the well known "intermittency effect" which influences calibrations made with a slowly rotating sector. The sector has nine steps, each one subtending half the angle of the next wider one and producing a spectrum approximately ½ mm. in width on the photographic plate.

The step-slit is mounted directly in front of the spectrograph slit which is opened so as to be wider than the widest slit of the calibrating device. The step-slit has ten steps, the ratio in width of adjacent steps being approximately 1.4 to 1. The narrowest step has its diffraction pattern well within the aperture of the collimating lens and is 0.072 mm. in width. The widest step is 1.421 mm. wide and its projected width on the photograph plate is 75 Angstroms at Hγ and 162 Angstroms at Hα. The strips of spectrum produced by the step-slit are approximately ½ mm. wide.

The source of light is an opal glass screen illuminated by a 200-watt lamp and the intensity may be varied by moving the opal glass toward or away from the spectrograph slit. For the region 4000-5000 Angstroms a Corning Red Purple ultra filter 1 mm. thick is

*For a comprehensive discussion of plate-calibrating devices see an article by G. R. Harrison, J.O.S.A. *24*, 59. (1934).

used to redistribute the spectral energy of the source and for panchromatic emulsions we use a "Daylight" filter. The intensity of the light was varied so that the exposure times using sector and multiple slit were the same.

Two series of comparisons were made, each comprising four plates, the first using E 33 emulsion and second with Ilford's Special Rapid Panchromatic. The plates were given brush development in Eastman D 11 developer, and were then analysed with the self-recording photoelectric microphotometer of the observatory. Calibration curves were formed from the measures of the microphotometer records by plotting the galvanometer deflections against the common logarithms of the exposures. The numerical values of the exposure for each strip are found from meaurements of the sector and step-slit openings. Samples of these calibration curves are shown in the accompanying diagram in which the crosses refer to sector calibrations and circles to the step-slit calibrations. Individual measurements at each wave-length on four different plates appear on the diagram.

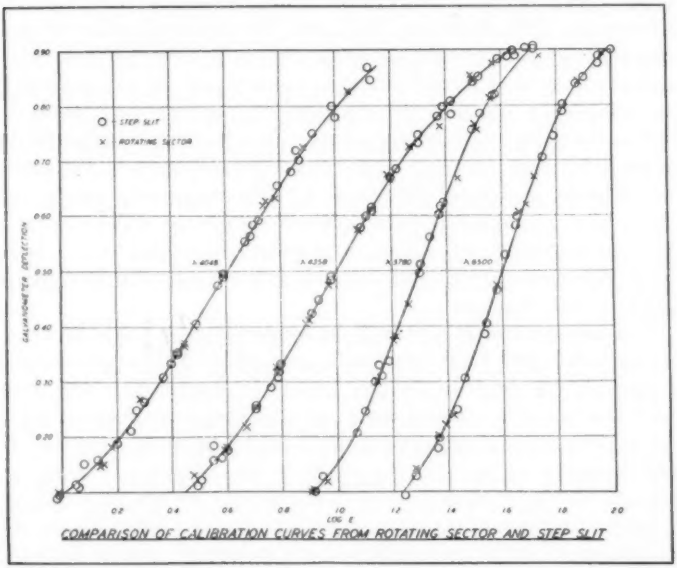
The measurements on the E 33 emulsion were made at wave-lengths 4000, 4200, 4400 Angstroms, and indicated that there existed no sensible difference in the two types of calibration. The same result was found in the measurements made on panchromatic emulsion for the wave-lengths 4046, 4358, 5780, 6500 Angstroms. In order to secure an objective estimate of the difference between the two sets of calibrations, the central portions of the curves were represented by straight lines found by least-squares solutions, for the wave-lengths λ4358 and λ6500. All measured points between galvanometer deflections 0.15 and 0.75 were used. The resulting slopes of these lines and their probable errors are as follows:

SLOPES OF CALIBRATION CURVES

	λ4358	λ6500
Sector	0.827 ± 008	1.367 ± 004
Step-slit	0.805 ± 009	1.362 ± 005

The values given above indicate the agreement between calibrations by sector and step-slit shown in the diagram, and we con-

clude from this that the two methods are equally valid as used at this observatory. The effect of a wide slit in the step-slit calibrations would be expected to give the greatest difference at λ6500 where the purity is lowest and change of emulsion sensitivity (with λ) the greatest. However, the two methods appear to be actually in better agreement at λ6500 than at λ4358 where the lack of purity



The plotted points represent measurements made on eight spectra. The origin of Log E is arbitrary for each plate in order to provide a mean curve for each wave-length.

would not be expected to have any appreciable influence on the slope of the calibration curve. It seems therefore that within the limits of error found in photographic photometry of this sort, the rotating sector and step-slit employed in the manner herein described produce the same calibration curves.

Dominion Astrophysical Observatory,
Victoria, B.C.

REVIEW OF PUBLICATIONS

Research Surveys of the Orbits and Perturbations of Minor Planets 1 to 1091, from 1801.0 to 1929.5, by A. O. LEUSCHENER. Publications of the Lick Observatory, Vol. XIX (Contributions of the Berkeley Astronomical Department), pp. 507+xxi. University of California Press, Berkeley, California, 1935.

Toward the close of the eighteenth century Bode, a German astronomer, announced that a series of numbers, afterwards known as Bode's law, represented the distances of the planets from the sun with one exception, there being no planet corresponding to the distance 2.8. Shortly after this announcement, on January 1, 1801, to be exact, Piazzi, while observing certain stars, noticed one that seemed to have a different motion and a few nights of observing established it not as a star but as a planet and its distance was approximately 2.8. This was the first asteroid or minor planet discovered. Piazzi named it Ceres. Four other minor planets were discovered in the first half of the century but the discoveries came very slowly until the introduction of the photographic method of search by Wolf near the close of the nineteenth century and since then some thousands have been discovered.

Only some 1,300 have, however, been given permanent numbers. When a minor planet is discovered it is given a temporary designation indicating the year and the order in the year of its discovery. When the orbit is determined and the planet is established as a new one it is then given a permanent number and the discoverer has the honour of giving it a name.

Of the thousands of minor planets only one, Vesta, is visible to the naked eye and that only occasionally. Very few in fact show disks even in the largest telescopes. Ceres is the largest with a diameter of 480 miles but many are not more than a mile in diameter. They travel around the sun but, unlike the larger planets, their orbits vary greatly in their inclination to the ecliptic and many have highly eccentric orbits. Some have variable light.

Minor planets are of great interest to astronomers not so much because of their orbits or their size but because of their near ap-

proach to the earth. Eros, discovered in 1898, was considered the closest of the planets as it came within fourteen million miles of the earth, but in 1932 two minor planets, not more than a mile or two in diameter, were discovered which come much closer. Amor, one of these, is about ten million miles from the earth at its nearest approach and the other comes within three million miles of the earth's orbit, its perihelion being eight million miles within the orbit of Venus.

With over one thousand minor planets already discovered, the number increasing rapidly, the inclination and eccentricity of their orbits differing greatly, and their diameters being so small that they are star-like in appearance, the problem of preserving these discoveries has developed into a stupendous one. For many years the major burden of this task was carried by the Berlin Rechen-Institut, but in 1922 the National Research Council of the National Academy of Sciences published a so-called preliminary survey of twenty-one minor planets prepared by Dr. A. O. Leuschner, of the University of California, assisted by Dr. W. F. Meyer and Dr. H. Thiele.

The first paragraph in the introduction to this preliminary survey states briefly and clearly just why the survey was undertaken. It is as follows: "With approximately one thousand asteroids discovered and believed to be sufficiently observed to permit of fairly reliable orbit determinations, as indicated by the permanent numbers assigned to them, the task of preserving these discoveries has grown so stupendous that the time seems to have arrived for an analysis of the present astronomical practice in providing the necessary additional observations and calculations." The General Assembly of the International Astronomical Union, meeting at Cambridge, England, in 1925, passed a resolution endorsing the continuation and completion of the Research Surveys for all minor planets. The work began in 1926, with Dr. H. Thiele as Research Associate and with several others assisting, and the present work—"Research Surveys of the Orbits and Perturbations of Minor Planets 1 to 1091, from 1801.0 to 1929.5," Vol. 19, Publications of Lick Observatory—is the result.

Dr. Leuschner, while recognizing the need of preserving the discoveries, states that "The preservation of planetary discoveries by observation and prediction with the aid of approximate pertur-

bations is not the ultimate aim of astronomical science, but a necessary and unavoidable means to the end. The ultimate aim rests on the determination of mean elements and general perturbations which hold for all time or at least for very long periods within the limits of accuracy set by observations." Further on he states "The proposed programme of fundamental investigations cannot supersede the present astronomical practice in caring for the minor planets in the immediate future but . . . will be of great assistance for the practical purposes of prediction, and should gradually solve the now stupendous task of preserving planetary discoveries, while furnishing at the same time the data for the more fundamental aims of astronomical science."

He emphasizes the absolute necessity of accurate osculating elements for fundamental investigations of the perturbations, and points out the danger of the present practice of changing elements for immediate ephemeris purposes, as it may lead to the wrong interpretation of available elements. The recent investigation on the theory of the motion of Vesta by N. Voronov (AN, 254, 331, 1935) is cited as an example of the scientific value of the plan of successive steps in deriving rigorous numerical theories by adding to first order perturbations of Jupiter and other planets those of second and higher orders, fundamental elements having been already determined.

The progress in recent years in the derivation of fundamental elements and of general perturbations is shown by the increase from 36 to 223 in the number of planets for which general perturbations have been derived with accuracy sufficiently satisfactory for use in determining ephemerides. This rapid increase in available fundamental elements and general perturbations will gradually reduce the need for changes of the elements of the numbered planets—over the period 1910-1935 the Rechen-Institut recorded 3,564 such changes of the elements of the 1,301 numbered planets.

Attention is called to the amount of duplication and repetition of investigations as shown by the surveys, and hope expressed that investigators will find the surveys a valuable aid in interpretation of existing data before attempting new investigations. The writer expresses the opinion that "the greatest progress in the study of planetary motion, with the least expenditure of effort, may be made by careful interpretation" of the basic material in the survey.

The restriction in the planets included and in the period covered in the survey was necessary because of the rapidity with which new planets were being discovered and also because of the great volume of new material being published. Since then, however, the survey has been extended to include the 1,301 planets numbered up to December, 1934, and the published material is practically complete to January, 1934. This extension is to be included in a revised survey (Dr. Leuschner asks to be notified of any omissions in this survey) or as an appendix to the present survey.

Some idea of the work involved in the surveys is given by the fact that approximately 20,000 elements were recorded and 25,000 cards or sources were used for reference, the material in these being extracted from 3,500 volumes, including 150 sets of publications.

The general plan of arrangement of material for each of the 1,091 planets is as follows: "Discovery data—Preliminary orbits with basic dates.—Later improvements of orbits with information concerning the perturbations that have been taken into account, including, if available, statements in regard to methods used; nature of the perturbations, whether special or general; accuracy aimed at by the author, and other pertinent data.—Tabulation of residuals in later oppositions after each new orbit in so far as they are essential or useful in appraising the degree of precision attained through the new investigation as an aid for the selection of fundamental data as a basis for the improvement of elements and theories.—Largest perturbation terms with periods and amplitudes for planets (1) to (500).—Comments and interpretations by authors or by the writer and his collaborators are interspersed throughout the surveys.—Tabulation of the more important sets of elements."

In addition to the material published much more was accumulated but not published as it was not considered of importance to this particular project. All such material, however, has been preserved on cards so is readily available for reference. Restricted by the necessity of keeping the cost of such a publication within reasonable limits, Dr. Leuschner and his assistants have presented to all interested in minor planets and kindred problems a most comprehensive yet not too inclusive record of all available data re minor planets up to number 1,091 inclusive and to them are due congratulations on so efficiently performing such a timely task.

R. M. MOTHERWELL

METEOR NEWS

Observations relating to meteors and meteorites are cordially invited.

A Daylight Meteor

The report of a bright daylight meteor which appeared in the southern sky at 1.25 p.m. Feb. 1st has been received from Mr. Cecil H. Plunkett of Stanleyville, Ont. This phenomenon was followed by a rumbling sound commencing a minute and a half after the meteor had disappeared. Observations of such objects are of great interest and the writer is very anxious to hear from any one who may have observed the meteor described above.

Observations of the Geminids in 1936

The Geminid meteors would undoubtedly be a more popular shower for general observation if it were not an unfortunate fact that cloudy weather and the Geminid maximum coincide far too frequently. When it is clear in the middle of December the temperature is, as a rule, low enough to render long spells of meteor observing rather rigorous. The enthusiast who braves the December weather, however, is generally rewarded by a fair showing of meteors and 1936 was apparently no exception.

Unfortunately, the Ontario observations of this shower were far from numerous, a result owing chiefly to poor weather conditions. The only night near the maximum when there was any clear weather at the Dunlap Observatory was on December 12-13. During the first half of the night the sky was completely covered with clouds but these suddenly cleared away shortly before midnight. The writer made exposures with three spectrographs and one direct camera during the morning hours of December 12-13. The visual observers had been dismissed earlier in the evening because of the inclement weather and so only a very sketchy idea of the frequency of Geminids was obtained. The writer was able to count meteors for an interval of 15 minutes and during this time observed 2 Non-Geminids and 12 Geminids, four of which were of magnitude –2 or brighter. This very brief count would indicate a frequency comparable to the Perseid meteors in August. No meteor spectra were

photographed but three interrupted Geminid trails were obtained with the direct camera of aperture ratio f/2.0 equipped with the rotating shutter used previously in the Perseid and Leonid observations.

Geminid observations were carried out at two other stations in addition to the Dunlap Observatory. Mr. Jack Grant at Orillia again conducted a very successful program of photographic observations using lenses of speeds f/1.9 and f/6.3. Mr. Grant also observed visually and plotted 19 meteors but since this work was done in the intervals between changing plates the results cannot be used for meteor rates. Six Geminids were photographed at Orillia during two nights of observation, three with each camera. The f/6.3 lens covered a field nearly three times the area of that covered by the f/1.9 lens and this evidently compensated for the slower speed. Though, for meteor photography, the writer usually recommends a lens at least as fast as f/4.5 it should be remembered that it is quite possible to obtain results with slower lenses and those lacking a fast lens need not give up the idea of co-operating in meteor photography. In this type of astronomical investigation persistence often plays a bigger part than the quality of the equipment. Acton was the third station where observations were carried out and here Mr. Neil McNabb recorded 14 meteors visually in 61 minutes of observation. The results of the visual and photographic programmes are summarized in the Table. The last column gives the rates reduced to six observers.

OBSERVATIONS OF THE GEMINID METEORS, 1936

Visual

Station	Date	Time(E.S.T.)	Meteors G	Meteors NG	Reduced Rates G	Reduced Rates NG
D.D.O.	Dec. 12–13	2.45–3.00	12	2	160 *	30
Orillia	12–13		10	2		
	13–14		5	2		
Acton	12–13	11.35–1.07	10	4	35	14
		Totals	37	10		

Photographic

	Station	Date	Total Exposure time	Meteors Photographed
Spectrophotography.	D.D.O.	Dec. 12–13	12.3 hrs.	0
Direct Photography.	D.D.O.	12–13	3.2	3
	Orillia	12–13	8.1	3
	Orillia	13–14	9.8	3

*Not plotting.

Unfortunately, it just happened that no meteor was photographed at both Orillia and the Dunlap Observatory. However, the brightest meteor photographed at the latter station was accurately plotted in Orillia and one of the meteors photographed in Orillia was observed by Dr. J. F. Heard in Richmond Hill so that fairly good heights will be available in these two cases. The writer would again like to call the attention of amateur photographers to the importance of photographic meteor observation. It is hoped that many more volunteers in this field will be found in the ranks of the Society.

Two Persistent Meteor Trains

Another very fine train observation has been received from M. Loreta in Bologna. The meteor was a Leonid and appeared near the eastern horizon at 22.17 G.C.T. on the evening of November 16, 1936. It was estimated as of magnitude –4. The train was white in colour and remained visible in binoculars (aperture 1.8 inch) for 5 minutes. Distinct train drift was noted during this interval as shown in M. Loreta's drawing, reproduced in Figure 1. The "V" shape of the train just before it disappeared is interesting.

What was apparently the same meteor was observed by M. Karl Wilfert at Pellendorf near Vienna, the train being described as somewhat greenish in colour and remaining visible to the naked eye for a little over a minute. Unfortunately, the Pellendorf observation of position was rather indefinite and does not allow of a computation for train height. It indicates qualitatively that the train was probably in the neighbourhood of 80 to 100 km above the earth's surface. Assuming an average height of 90 km and allowing for the rotation of the earth the train drift observed from Bologna represents a minimum possible value of roughly 250 km/hr in a general direction south and up. Since the meteor was in all probability about 500 km from Bologna and thus observed through a great thickness of atmosphere, it must, as M. Loreta states, have had a very high intrinsic luminosity.

The second meteor shown in Figure 1 was observed by Mr. S. Hoare of the Vancouver centre of the Society. Mr. Hoare states that the fireball was moving very rapidly and lit up the whole land-

scape with a strange blue glow. The train remained visible for several seconds. There must be a large number of very bright meteors seen every year by the members of the Society. It would

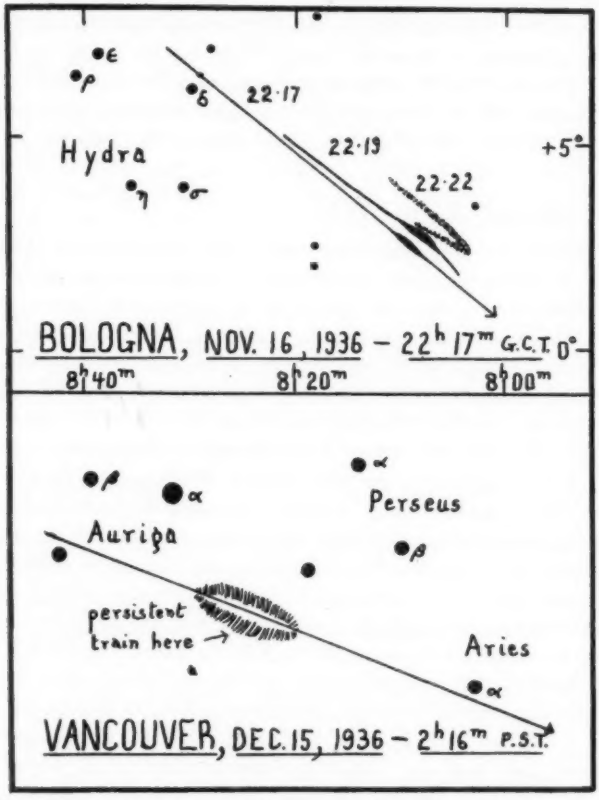


FIG. 1.—Drawings of two bright meteors which left persistent trains.

be a fine thing if these were all reported to this section of the JOURNAL, especially if we could have observations of train drifts of the type so ably made by Loreta.

P. M. M.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Note on the Coming Eclipse of Zeta Aurigae

On April 22, 1937, the B component of ζ Aurigae will again enter eclipse. This year the star, unfortunately, will be rather far west before observing can be commenced in the evening. Every effort, however, should be made to determine the brightness of the star for at least a week preceding totality.

It is to be hoped all who have suitable equipment will co-operate in observing this interesting star. Fourteen observatories in Europe and Asia have already signified their willingness to undertake observations and we trust that many competent amateurs will also join in the effort to obtain a satisfactory light-curve. The writer will be glad to reduce the measures, and transfer them into a homogeneous system, for those who do not care to undertake this work themselves, and to receive any observations as soon as possible after the eclipse.

Mount Wilson Observatory
Pasadena, California

William H. Christie

The Largest Refracting Telescope

The largest refracting telescope in use is the 40-in. at Yerkes Observatory. In the article "Telescope", Encyclopedia Britannica, 11th ed., a 49-in. is mentioned as having been exhibited at the Paris Exhibition of 1900. A recent letter from Mme. G. Camille Flammarion, Secretary of the Astronomical Society of France, gives the following information as to this instrument:

This telescope, which was built by Mm. Mantois and Gautier, was mounted horizontally, in siderostat form, with a plane mirror 2 metres in diameter. It had two objectives, one for visual and the other for photographic work. These were 1.25m. in diameter with a focal length of about 60 metres and weighed 600 kg. each. The siderostat mirror weighing 3,600 kg. was cast at the Teumont glass works under the direction of M. Despret. The steel plate tube was 1.50m. in diameter and weighed 21,000 kg.

The performance of the instrument was disappointing. It was

dismantled, the tube and mechanical parts sold and the great mirror and the objectives stored at the optical laboratory of the Paris Observatory where they remain.

H. B. B.

A New Comet—Whipple (1937*b*)

The Harvard College Observatory has announced the discovery of a 12th magnitude comet by Dr. F. L. Whipple, on a photograph taken at Harvard on 1937 February 7, 378 U.T. The position is R.A. $13^h\ 19^m\ 30^s$, Dec. $+35°26'$; daily motion, $1^m\ 18^s$ east; $22'$ north; nucleus, tail less than one degree.

From observations on Feb. 4, 7, and 15, Whipple and Cunningham determined the following elements:

T	1937 June 22.068	i	41°3′47″ 1937.0
ω	111°26′57″ (1937.0)	q	1.66084
Ω	127 4 7 (1937.0)		

From these elements the following ephemeris is predicted for the coming month:

	α1937.0			δ1937.0		ρ	r	Mag.
	h	m	s	°	′			
Mar. 4	13	49	47	+45	42	1.46	2.19	10.4
8	13	54	2	+47	25	1.43	2.16	10.3
12	13	58	2	+49	6	1.40	2.13	10.1
16	14	1	46	+50	44	1.38	2.10	10.0
20	14	5	11	+52	17	1.36	2.07	9.9
24	14	8	18	+53	45	1.35	2.04	9.8
28	14	11	6	+55	7	1.33	2.01	9.6

ρ = distance of comet from earth; r = distance of comet from sun in astronomical units.

This information is obtained from *Harvard College Observatory Announcement Cards 403, Feb. 15; 404, Feb. 16.*

Unfortunately, despite the fact that at perihelion the comet is well placed with respect to the earth, it will probably, due to its great distance from the sun, not exceed the 8th magnitude, and hence will not be an easy object for visual study.

F. S. H.

MEETINGS OF THE SOCIETY

ANNUAL AT-HOME OF THE SOCIETY

On Friday evening, January 15th, the Annual Meeting and "At Home" of the Royal Astronomical Society of Canada was held in the Physics Building of the University of Toronto.

The meeting was well attended and the programme provided was well received, being instructive and entertaining.

The President, Dr. Ralph E. DeLury of the Dominion Observatory at Ottawa, spoke on the subject of "Recent Developments in Astronomy". Dr. DeLury reviewed the recent developments in astronomy, stressing particularly the spectographic work which is being carried on in practically all of the large observatories in the world and the progress made in mapping and plotting the more prominent celestial bodies in the universe.

The meeting was presided over by Dr. William Findlay of Hamilton and after Dr. DeLury's address the audience moved to the physical laboratory in the north end of the building where Dr. J. Satterly entertained them for about an hour with many interesting and instructing demonstrations of the physical properties of liquid air. One of the features of the demonstrations by Dr. Satterly, of course, was his bubbling wit and humour which kept his audience in a spirit of merriment throughout the entire lecture and demonstration and put them in very good shape for the refreshments which were served as a fitting climax to an enjoyable evening.

R. H. COMBS, *Recorder*.

AT TORONTO

November 17, 1936.—The regular meeting was held in the usual place, with Mr. E. J. A. Kennedy, Vice-Chairman, presiding. The attendance was so large that the room was filled to overflowing.

The following were elected members

B. Haurwitz, Ph.D., Toronto
Mrs. A. Stevenson, Toronto
Mr. C. A. Moodie, Scarboro Bluffs.

Mr. F. K. Dalton, a member of the society and an industrious amateur astronomer, gave an account of the more outstanding observations he had made during recent years. He showed slides of pictures he himself had taken of the solar eclipses of 1925 and 1932, the tidal bore at Moncton, and the lunar eclipse of 1935; besides these he had slides of other interesting celestial objects which are visible through a small telescope. A sun-circle, which he had designed and constructed, he exhibited with a complete explanation.

Mr. R. H. Combs, also a member of the society, then showed motion pictures taken at the McMath-Hulbert Observatory of the University of Michigan, which

the society had so fully enjoyed on a previous occasion. A new reel showing the phenomena of Jupiter's satellites was also shown.

December 1, 1936.—The regular meeting was held in the usual place with Mr. A. R. Hassard presiding..

Mr. Wm. Lencki, Mr. Alex. Jardine and Mr. Alvin Barnard, all of Toronto, were duly elected, and Miss A. M. V. Rosseter nominated for membership.

Mr. Andrew Thomson, M.A., of the Meteorological Service of Canada, presented the paper of the evening, entitled "Recent Progress in Meteorology".

Mr. Thomson spoke of the demands which aviation has placed on the meteorological service in the last four or five years, and the great advances made in this type of forecasting. Weather forecasts must now be made for altitudes of 6,000 feet and over. Contrary to the general belief, the atmospheric pressure areas vary in their heights, low pressure areas extending considerably higher than the high pressure areas.

Many new stations have been added in the last five years. In the United States alone 25 have been added and are reporting hourly, instead of twice daily, as previously. Canada is also increasing the number, but there are still some sections where private interests are relied upon for the information. Other countries nearer the tropics, South Africa, Straits Settlement and New Zealand, have also been adding to the number of stations and are doing valuable work in reporting outbreaks of warm air.

While commenting on the advances made in theoretical meteorology, Mr. Thomson showed some interesting slides on the departure of Capt. Stevens's stratosphere balloon, Explorer II, from Rapid City, South Dakota.

Recent observations show that the composition of the gases in the atmosphere are not constant after 12 miles, the lighter gases predominating at the higher altitudes. The temperature of the air also decreases very rapidly during the first four or five miles, then gradually warming until it reaches a temperature of 50 to 60 degrees Fahrenheit at about 24 miles high.

The interest shown in the lecture was evidenced by the numerous questions asked.

December 15, 1936.—The regular meeting was held in the usual place, Mr. E. J. A. Kennedy presiding, owing to the illness of the chairman, Mr. A. R. Hassard.

Miss A. M. V. Rosseter was elected to membership.

The assistant librarian informed the society that she had with her, at the meeting, certain books from the library, which could be loaned to any member of the society.

The paper of the evening, "Legends of the Winter Constellations", was given by Mr. J. R. Collins. He refreshed in our minds the winter stars and the stories the ancient Egyptians, Greeks and Romans built up around the more important star groups. He also pointed out that the personnel of the Greek Argonaut Expedition still persists in the nomenclature of the stellar configurations.

The phenomena for the next few weeks were read by Mr. F. L. Harvey. After the announcement of the Annual Meeting of the Royal Astronomical Society of Canada on Jan. 12, the annual At-Home on Jan. 15, and the joint meeting of the Centre with the Royal Canadian Institute on Jan. 27, when Dr. D. H. Menzel of Harvard will be the guest speaker, the meeting adjourned.

Annual Meeting.—Following the regular meeting, the Toronto section of the Royal Astronomical Society of Canada held its Annual Meeting, Mr. E. J. A. Kennedy in the chair.

Mr. S. C. Brown, Secretary, gave a report of the membership for the past year. There being nine new members, including one life-member, and nine non-residents of the city withdrawing their membership, the total number of members in the Toronto section is unchanged.

Owing to illness the Treasurer, Mr. Maybee, was unable to present his report.

The nominating committee, Dr. R. K. Young, Dr. L. Gilchrist, Mr. J. H. Horning, and Mr. J. R. Collins moved the nomination of the following as officers for 1937:

Hon. Chairman—Dr. C. A. Chant
Chairman—E. J. A. Kennedy
Vice-Chairman—S. C. Brown
Secretary—F. L. Harvey
Recorder—F. S. Patterson
Treasurer—J. E. Maybee
Curator—R. S. Duncan.

Members of Council—Dr. D. S. Ainslie, Dr. L. Gilchrist, Dr. F. S. Hogg, J. H. Horning, Dr. P. M. Millman, Rev. C. H. Shortt, Dr. R. K. Young, and the Past Chairmen—A. F. Miller, A. F. Hunter, J. R. Collins, and A. R. Hassard.

This motion was carried.

F. SHIRLEY PATTERSON,
Recorder.

Special Meeting, January 29, 1937.—A joint meeting of the Royal Canadian Institute and the Toronto Section of the Royal Astronomical Society of Canada was held on Wednesday evening, January 29, 1937, in Convocation Hall, University of Toronto. Dr. C. A. Chant, Director Emeritus of the David Dunlap Observatory, University of Toronto, introduced Dr. Donald Howard Menzel, of Harvard Observatory, who was the guest speaker of the evening.

Dr. Menzel directed the Harvard solar eclipse expedition at Ak-Bulak, near the Siberian border, on June 19, 1936. His lecture, "Russia In and Out of Eclipse", was an account of the preparation of the equipment and the setting up of the camp on the Russian steppeland. Several reels of motion pictures plus some very good stills gave the audience a clear impression of the meaning of a modern eclipse expedition; and also of provincial Russia. Dr. Menzel found the Russians most enthusiastic in their urge to make the expedition successful; and never in the whole three months of his stay in Russia did any of his enquiries into economic industry meet with rebuff.

Professor Thomson, president of the Royal Canadian Institute, expressed the appreciation of the audience to Dr. Menzel, and the meeting adjourned.

F. SHIRLEY PATTERSON, *Recorder*.

List of recently elected Members in the section "Members at Large":
Blaauw, Mrs. Edmund E.: 190 Ashland Avenue, Buffalo, N.Y., U.S.A.
Boivin, Alberic: B.P. 3 Jonquiere, P.Quebec.
Clegg, Philip: P.O. Box 267, Cheshire, Conn., U.S.A.
Cox, Robert G.: 1074 Park Place, Brooklyn, N.Y., U.S.A.
Eichelberger, A. G.: W. Shawmont Avenue, Roxborough, Philadelphia, Pa.,U.S.A.
Feely, H.M.: 5807 Elmer St. Pittsburgh, Pa., U.S.A.
Huey, Walter B., M.D.: 404 Clinton St., Illinois, U.S.A.
Jones, F. W. C.: 4008 Biddle Avenue, Wyandotte, Mich., U.S.A.
Kilburn, O.: 140 Manitoba St., St. Thomas, Ont.
Lindsay, R. F.: 26 St. Denis Avenue, Quebec City, P.Q.
Milne, Dr. D. M.: 805 Fidelity Building, Portland, Maine, U.S.A.
Richardson, E. G.: 1238 E. Broadway, San Gabriel, Calif., U.S.A.
Robson, L. R.: 314 5th Avenue N., Saskatoon, Sask.
Ross, I. M.: c/o Iraq Petroleum Company, Haifa, Palestine.
Rowley, Fred J.:The Rowleys, Riddell's Bay, Bermuda.
Smith, E. E.: Reston, Manitoba.
Skeer, R. T.:15998 Nela Crest Avenue, Cleveland, Ohio, U.S.A.
Taylor, E. W.: Pinkham, Sask.
Terwangne, Baron Renaud de.: Chateau á Heyst-op-den-Berg, prov.d'Anvers, Belgium.
Zahner, Donald D.: 142 W. Cedar St., Webster Groves, Mo., U.S.A.

AT EDMONTON

April 4, 1936.—Prof. I. F. Morrison, of the Department of Civil Engineering in the University, spoke on Astronomy and Surveying. Without going into too great technical detail, he described how latitude determinations could be made with the zenith telescope and an ephemeris, how longitude could be found with the meridian transit and a surveyor's chronometer, and how azimuth determinations could be made on a suitable star with a theodolite. The various instruments were set up on the lecture bench and demonstrated.

May 7.—Dr. E. H. Gowan, of the Physics Department in the University, spoke on Römer, Bradley, and the Velocity of Light. He mentioned the early attempt of Galileo to find the velocity of light, the calculations by the Danish astronomer, Römer, based on long-continued observations of the eclipses of Jupiter's first satellite, and the measurements of Bradley, based on the phenomenon of stellar aberration. Although these first successful attemps to find the velocity of light depended on astronomical observations, more recent and accurate experimental work was nevertheless purely terrestrial.

October 8.—Mr. R. Chambers gave an account of the meteorological observatory which from 1883 to 1904 was situated on the summit of Ben Nevis in Scot-

land, the highest point in Great Britain. The observatory was finally closed down for lack of funds, the government holding that the scientific information obtained was not worth the expense. Mr. Chambers paid tribute to the energy and enthusiasm of Mr. Wragge, who carried out observations himself on Ben Nevis for many years and was mainly instrumental in getting the observatory established.

November 12.—Prof. E. S. Keeping, of the Department of Mathematics, gave a talk on Planetaria. After a brief discussion of mechanical planetaria or orreries, he dealt with the historical development, the method of operation, and the effects achieved in modern planetaria. The speaker mentioned his personal experiences of demonstrations in the Adler Planetarium, Chicago, and the Hayden Planetarium, New York, and the talk was illustrated by 24 lantern slides kindly loaned by Dr. Fox of the Adler Planetarium.

December 10.—At the annual banquet held in the Corona Hotel, Edmonton, the principal speaker was Mr. D. E. Cameron, Librarian of the University, who spoke on Astronomy in the Bible. After mentioning some of the astronomical references in the Old Testament, he discussed the reasons why astronomy is not more prominent than it is, and suggested that numerous references to a primitive sun-worship derived from Egypt and to the moon-cult prevalent in Syria had been expunged in a later rescension of the sacred books. When the Israelites turned to the worship of Jehovah they endeavoured to root out all traces of the ancient faith, often substituting words of derogatory or shameful meaning for those referring to the Sun-god. The speaker gave several instances where apparently puzzling stories became intelligible when references to the Sun-god or his images were understood in place of something at first sight quite different.

E. S. KEEPING, *Hon. Sec.*

AT VANCOUVER

November 17, 1936.—The 42nd regular meeting was held in the Science Building of the University of B.C., Mr. C. A. McDonald presiding.

The speaker of the evening was Dr. G. M. Shrum, of the University of British Columbia, and his subject was "Atomic Collisions" (with experiments).

The speaker commenced his lecture by discussing the concept of the atom from the time of Dalton to the discovery of the electron by J. J. Thomson in 1897. An early model of the atom was known as the Kelvin atom. Much of the information was obtained from considerations involving the kinetic theory of gases. The number of collisions per second and the mean free path of the atoms was discussed and some explanation of the subject of elastic collisions was given by the speaker. The latter was demonstrated to the audience by means of suspended steel balls.

Dr. Shrum then explained that after the discovery of the electron and following the work of Rutherford on the scattering of alpha rays, it was necessary to modify our views of the structure of an atom. Rutherford introduced the idea of the nuclear atom. The parallel between this atom model and our solar system was emphasized by the speaker. It was shown that the electron spins on its axis,

and revolves about a central nucleus which is itself spinning, much the same as the earth spins on its axis, and rotates about the sun, which in turn spins about its own axis.

The question of the disintegration of atoms was discussed at some length. It was shown that to produce a permanent change in an atom it was necessary to hit the central nucleus. It was shown that alpha particles from radioactive substances provided suitable projectiles for the disruption of the nucleus. The experiments of C. T. R. Wilson with cloud tracks were explained and many slides shown. The first successful experiment on the transmission of matter, using natural radioactive substances, was carried out in the Cavendish Laboratory in 1919.

Some time was spent explaining the various methods which have been used to produce very high-speed particles for atomic disintegration work. The most successful of these devices has been the "Cyclotron" developed by E. O. Laurence of the University of California at Berkeley. This method was explained with the aid of slides.

The properties of the neutron were discussed and particularly its use in the bombardment of atoms. The various methods for the production of neutrons were explained and also the importance of the particles in the recent work on radioactivity. Some of the biological effects of these rays were also explained. The production of "Slow neutrons" was explained in some detail, aided by demonstrations with steel balls.

Finally a demonstration of the production of artificial radioactivity in silver was shown. A silver coin was exposed to slow neutrons and then the resultant beta ray activity was demonstrated by means of a loud speaker and Geiger-Müller tube. In the process the silver was transformed into cadmium. It was explained that this type of transmutation was now very common. Finally a demonstration of the intense activity of very penetrating gamma rays from radon was carried out with the aid of Mr. Kenneth McKenzie.

In closing, Dr. Shrum explained that the demonstrations had been made possible only through the coöperation of Dr. E. L. Harrington, of the University of Saskatchewan, and the Cancer Commission of that province. They had loaned the radon and beryllium for the neutron source. The lecturer emphasized his great indebtedness to them.

A number of questions were asked by the members present and replies given by Dr. Shrum, after which a vote of thanks was moved and seconded to Dr. Shrum for his very interesting lecture.

J. W. MOORE, *Secretary*.

December 8, 1936—The 43rd regular meeting of the Vancouver Centre was held in the Science Building of the University of B.C. on Tuesday, December 8th, 1936, Mr. C. A. McDonald presiding.

As this was the Annual Meeting of the Centre the reports of the different officers were read and adopted.

Following this the election ballots were then counted; the list of the officers elected appears elsewhere.

The treasurer's accounts were audited by Mr. Thrupp and Mrs. Anderson.

Following this Mr. Thrupp gave a short talk in connection with Earthquakes and the possibility of predicting them in advance. The speaker referred to the study made by John Milne in Japan for 15 years of earthquakes and their causes, and who finally reported that it was impossible to predict them in advance. Also reference was made to the opinion given by the Smithsonian Institute that they were unable to predict earthquakes. Mr. Thrupp stated that the reason for the failure to predict earthquakes by these eminent institutions was in his opinion due to the fact that our "Physical Theories", especially Newton's gravitation and Einstein's theory, needed considerable revision. Mr. Thrupp called attention to his recent predictions at one of our meetings and also the report in the JOURNAL of an earthquake peak period around November 1st, 1936. and gave full details of how this prediction was fulfilled. A chart was exhibited by Mr. Thrupp showing stress peaks for 1937, as follows:

January, 1937, around the last week.....Slight quakes
Feb. 25th to March 5th.....Slight quakes
May 30th (about).....Largest quake of year
July 31st (about).....Slight quake
Nov. 15th (about).....Second most severe quake of the year

Details of the 1937 predictions and the fulfilment of last November quakes were given to the secretary for record by Mr. Thrupp.

The following demonstration and experiments were prepared and explained by Mr. Schurichi Kusaka and Mr. Robert Christy of the University of British Columbia for the benefit of the members after the meeting.

1—Method of Aluminizing mirrors by evaporating aluminum on a glass in high vacuum.
2—Bacteria in Microscope.
3—Sodium Spectrum and Fringes.
4—Laboratory experiment illustrative of measurement of stellar diameter by inferometer method.

J. W. MOORE, *Secretary.*

January 12, 1937.—The 44th regular meeting of the Centre was held on January 12th. Mr. H. P. Newton, president, occupied the chair.

Minutes of meeting of Dec. 8th, 1936 were read and adopted.

Mr. T. W. Fletcher was elected to membership.

Professor W. H. Gage of the U.B.C. and his topic, "Star Clusters and Nebulae" were introduced by the President. After distinguishing between the star clouds of the galactic plane and the local system of nearer stars, Prof. Gage classified star clusters as (1) Moving, (2) Open and (3) Globular. Moving and open clusters are found mostly in the galactic plane, where some 250 are more or less evenly distributed. By means of their proper motions and radial velocities, the speaker demonstrated a trigonometrical method of determining their distances, which vary between 500 and 2,000 light-years.

Globular clusters are much more compactly formed and more distant, appearing above and below the galactic plane, roughly between 8° and 60°. These clusters are in rotation. They contain many stars, the great cluster in Hercules numbering 100,000 or more, distributed much more densely than those in the sun's vicinity. Distances of 12,000 to 250,000 light-years are found by Shapley's method of Cepheid variables, which Prof. Gage outlined. Open clusters are believed to originate, in many cases, from globular, due to gravitational influence of the star fields of the galactic plane, as suggested by the distribution of the two types.

Nebulae of the diffuse type in the galactic system were shown to be light or dark, being concentrations of cosmic matter usually dark, but in some cases illuminated by adjacent stars. Evidences that our galaxy is a spiral nebula, much larger than any other we know of, were presented, after which the spiral and elliptical types were described and their vast distances referred to. The apparent receding motions of these island universes and the derived concept of an expanding universe were briefly discussed near the close. Prof. Gage's address contained much interesting information, organized in lucid and convincing order, and was well illustrated with numerous slides. The President expressed the thanks of the meeting and a brief discussion followed.

The attendance was good, in spite of a snow-storm.

J. TEASDALE, *Secretary*.

AT WINNIPEG

Annual Meeting, December 9, 1936.—The meeting was held in Theatre "E", University of Manitoba. The auditor's report showing a balance of $10.52 was adopted, the present active membership being 45. The nominations for the ensuing year were deferred to the close of the address, which was delivered by President A. V. Piggott, of the Science staff of the Isaac Newton Collegiate. After outlining the fallacies in the theory of Laplace regarding our solar system, he developed for his audience the Planetesimal Theory of Moulton and Chamberlin, and made mention of Jeans' discarding of the solar-prominences as nuclei in favour of purely tidal extrusions. The greater concentration of mass in the orbits of Jupiter and Saturn was accounted for; and the theory was seen to permit of retrograding satellites. The greater circularity of the middle orbits would be due to a better averaging of attractions throughout a long period of time. The double-armed forms of the nebulae were suggestive; but these could not be explained by analogy, comprising as they must, millions of solids with major motions. Some thought the preliminary cooling of the material in the condition it left our sun into even minor aggregations of solid presented inconsistencies for the theory.

Following some reports from observers with Dr. M. F. Bennett's telescope, nominations were approved as follows: *Honorary President*, Mgr. T. W. Morton; *President for 1937*, W. H. Darracott; *Vice-Presidents*, W. H. Kolb and W. R. Junkin; *Council*—P. N. Stokes, Dr. M. F. Bennett, Miss M. E. Watterson, Miss O. A. Armstrong, C. D. Dorsett; *Auditors*, L. W. Kozer and A. V. Thomas; *Secretary*, G. P. Morse.

G. P. MORSE, *Secretary*.

January 13, 1937.—A meeting was held in Theatre F, under President W. H. Darracott, who introduced Prof. W. A. Anderson of the Physics Department of the University. The subject was Michelson's determinations of the speed of light, pursued at intervals through a period of 50 years, with brief reference to previous determinations. Interesting biographical notes on the famous scientist were a feature of the address. Mr. R. D. Colquette was then called upon for his running comment on astronomical news, mentioning the observation of red nebulae. Attendance 28.

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